STAFF REPORT

ON

THE BENEFICIAL USES DESIGNATIONS AND WATER QUALITY CRITERIA TO BE USE FOR THE REGULATION OF AGRICULTURAL SUBSURFACE DRAINAGE DISCHARGES IN THE SAN JOAQUIN BASIN (5C)

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

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PART I INTRODUCTION AND BACKGROUND

Introduction

The preparation and adoption of a water quality control plan (Basin Plan) is required by California Water Code Section 13240. A Basin Plan is the basis for regulatory actions that are to be taken for water quality control. The Basin Plan is also used to satisfy Section 303 of the Clean Water Act which requires states to adopt water quality standards to meet federal regulatory requirements. Basin Plans are adopted and amended by the Regional Board using a structured process involving full public participation and state environmental review. A Basin Plan or amendments thereto, do not become effective until approved by the State Water Resources Control Board (State Water Board) and the Office of Administrative Law. A Basin Plan must consist of all of the following (Water Code Section 13050):

a) beneficial uses to be protected;

b) water quality objectives; and

c) a program of implementation needed for achieving water quality objectives.

In 1988, the Regional Board adopted an amendment to the San Joaquin River Water Quality Control Plan for regulation of agricultural subsurface drainage discharges from the Grassland Area of Merced County. A revision to that amendment is now needed.

The following staff report describes the first portion of a proposed Basin Plan Amendment. This staff report is composed of three parts. Part I is an introduction and background on the need for the Basin Plan Amendment but also includes a description of the watershed area to be covered by the Amendment. Part II provides a discussion and rationale for a listing of past, present and potential beneficial uses for the principal surface water bodies affected by the amendment. The primary focus of the beneficial use listing is water bodies is the Grassland watershed that includes Mud Slough (north), Salt Slough and the wetland water supply channels in the Grassland area. Part III contains a review of the available selenium water quality criteria for each designated beneficial use. These water quality criteria are scientifically based numbers that afford protection of a designated beneficial use.

This staff report will be the subject of a public workshop to be held by the Regional Board on 23 June 1995 in Sacramento. The workshop will deal only with beneficial use designations for the Grassland area water bodies and the San Joaquin River and the water quality criteria that should be used in developing water quality objectives for these water bodies. Written comments on the staff report and/or as a result of the workshop would be appreciated by **7 July 1995**.

A future staff report and workshop will cover proposed water quality objectives that need to be achieved to protect beneficial uses identified, a program of implementation for achieving compliance with the water quality objectives and a description of the monitoring programs that are needed to measure compliance with the water quality objectives. These future proposals are likely to generate considerable comment especially on the cost and feasibility of achieving the objectives.

Watershed Areas to Be Considered

The revised amendment being developed is for the San Joaquin River Basin Plan. The area covered by this Basin Plan is San Joaquin River and its tributaries, the principal drainage artery for the San Joaquin Valley. The River flow originates from mountain ranges on both the east and west side of the valley. The mountain ranges on the east (Sierra Nevada) and west side (Diablo Range) of the San Joaquin Valley differ in geology and climate which lead to striking differences in the hydrology and water quality of the streams and soils on the east versus the west side of the San Joaquin Valley. The Sierra Nevada range is composed of granitic material and is subject to a humid environment which accumulates a large snow pack in the winter. The lower elevation Coastal Mountains of the Diablo Range in contrast, are composed of sedimentary materials of marine and continental origin and only receive limited seasonal rainfall, primarily in the winter. Soils on the flood plain and on the alluvial fans east of the San Joaquin River are reflective of the granitic parent material and those west of the river reflect the sedimentary parent material and differ in mineralogy, chemical and physical properties (USDA, 1952). The result is that streams on the east side that are tributary to the San Joaquin River, are perennial and of good quality (low salinity) while west side streams are ephemeral and of poor water quality due to the marine sediments (high salinity and high levels of some trace elements) (Presser et al., 1990).

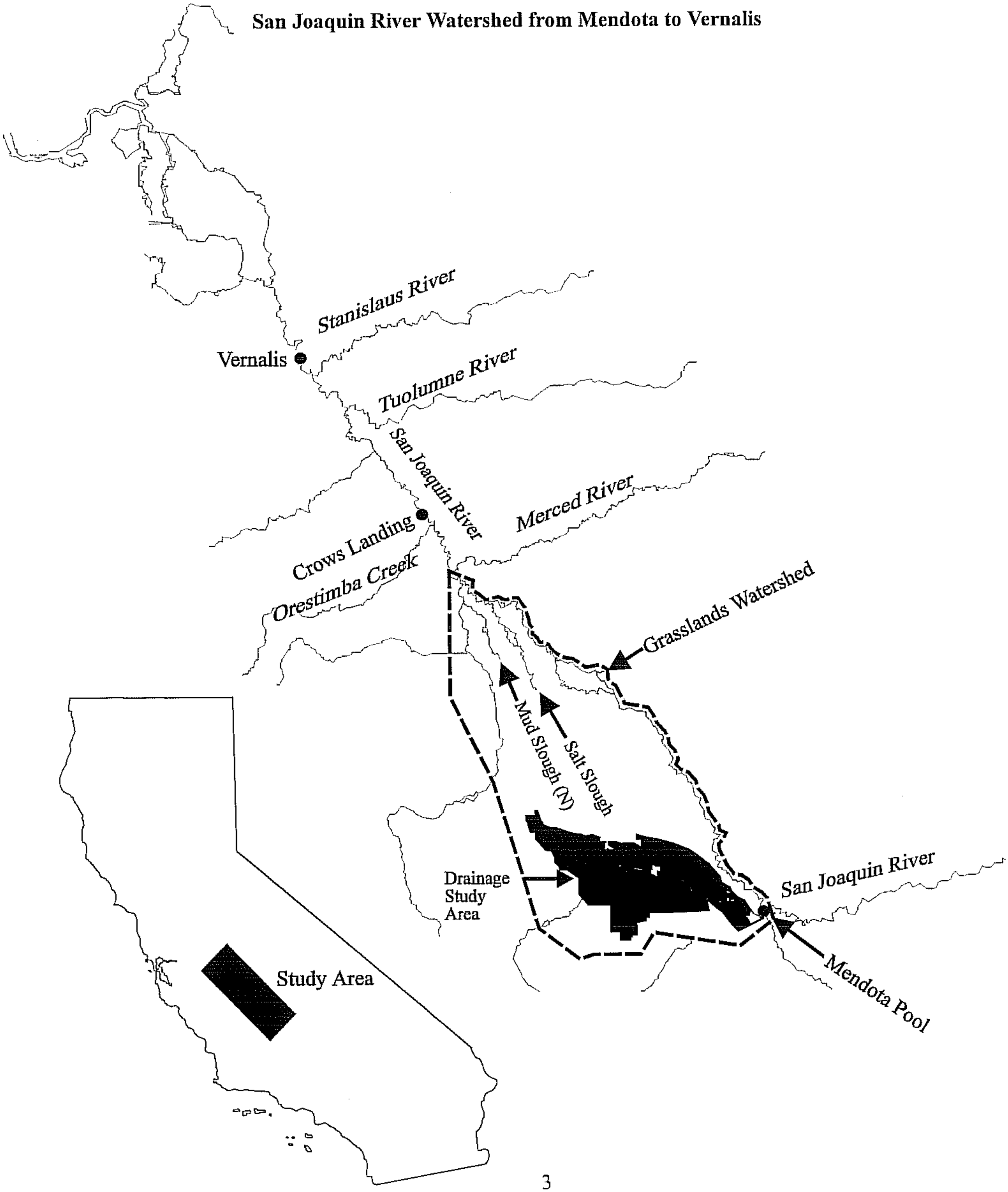
There are two hydrologic areas being considered under this Basin Plan amendment (Figure 1). The first is the Grassland watershed which includes the San Joaquin River from the Mendota Pool to the Merced River as its eastern boundary while the second is the main stem of the San Joaquin River downstream of the Merced River. Differences in geology and hydrology between the two areas significantly affects water quality and the steps needed to protect beneficial uses.

The Grassland watershed is one of the principal drainage basins within the western portion of the valley floor and is thus influenced by the geologic characteristics described above. The watershed is bounded on the west by the drainage of the Coastal Mountains of the Diablo Range that drain into the watershed; to the east, by the San Joaquin River; to the north, by the alluvial fans of Orestimba Creek and the Merced River; and to the south by the Tulare Lake Basin. The principal drainage ways for the Grassland watershed are Mud Slough (north) and Salt Slough. Both sloughs discharge to the San Joaquin River upstream of the Merced River inflow near the northern boundary of the watershed. These sloughs have undergone dramatic changes in their hydrology and water quality in the past century, primarily in the last 45 years, due to agricultural development and alteration of the San Joaquin River hydrology.

The second hydrologic area, the San Joaquin River downstream of the Merced River inflow, is primarily influenced by flows from the Sierra Nevada Mountains as described above. The tributary inflows downstream of the Merced River are from the Tuolumne and Stanislaus Rivers, each of which provides high quality flows. Water quality in this reach of the San Joaquin River is significantly influenced by the quality of discharges from the westside drainage basins such as those coming from the Grassland watershed and the amount of flow available from the eastside tributaries.

FIGURE 1

San Joaquin River Watershed from Mendota to Vernalis



Background

In 1983, high frequencies of waterfowl deaths and deformities were observed in Kesterson National Wildlife Refuge (Kesterson Reservoir) and were attributed to toxic concentrations of selenium in agricultural drainage that was entering the site. The source of the agricultural drainage to Kesterson was lands within the Westlands Water District. A survey of lands adjacent to Westlands Water District showed that agricultural subsurface drainage from a large area in the Grasslands watershed also contained high selenium levels. This drainage water was being discharged directly to the Grassland wetlands and the San Joaquin River.

A technical committee was formed (SWRCB Order No. WQ 85-1) to assess this discharge because of its potential impacts on beneficial uses of the San Joaquin River Basin. The technical committee developed a regulatory program including recommended water quality objectives and an implementation plan (SWRCB, 1987). In December 1988, the Central Valley Regional Water Quality Control Board (Regional Board) incorporated many of these recommendations into a Basin Plan Amendment for the Regulation of Agricultural Subsurface Drainage. As part of the Basin Plan Amendment, the Regional Board also adopted site specific molybdenum, boron, and selenium water quality objectives for the San Joaquin River, Mud Slough (north), and Salt Slough. Selenium objectives were also adopted for wetland water supplies. In setting these objectives, the Regional Board adopted a policy of controlling toxic trace elements, especially selenium, as a first priority.

The water quality objectives varied depending on the location of the water body relative to the Merced River. The reason for the difference was the amount of assimilative capacity available in the water bodies upstream and downstream of the Merced River. The San Joaquin River and its tributary sloughs upstream of the Merced River had less stringent objectives since the flow and quality of these water bodies are governed by agricultural irrigation and wetland return flows (effluent-dominated), while the objectives for the San Joaquin River downstream of the Merced River are more stringent because the natural flow of the San Joaquin River is dominated by the good quality inflows from eastside tributaries. A critically-dry year relaxation for boron and selenium also applied to the San Joaquin River downstream of the Merced River since natural flow from the eastside tributaries drops significantly during droughts.

The focus of the implementation plan adopted in 1988 was on drainage volume and pollutant load reductions through adoption of on-farm best management practices (BMPs)--primarily water conservation. Progress toward meeting water quality objectives was to be documented in annual Drainage Operation Plans (DOPs) which would describe the progress individual water and drainage districts were making toward adoption of BMPs. Waste discharge requirements were to be considered only if water quality objectives were not met by the compliance dates. The Regional Board also adopted a prohibition against activities that would increase the discharge of poor quality agricultural subsurface drainage. The Regional Board recognized that, as more information became available on the beneficial uses of the watershed and effectiveness of the BMPs, the basin plan amendment might have to be reconsidered.

The State Water Board approved the Regional Board Basin Plan Amendment in September 1989 but disapproved the proposed beneficial uses of Mud Slough (north) and Salt Slough. Following State Water Board approval, the U.S. EPA, who has approval authority over state water quality objectives, disapproved many of the adopted objectives. Boron objectives in all water bodies were disapproved. The selenium objective for the effluent-dominated water bodies upstream of the Merced River (10 µg/L) was also disapproved. These water bodies included Mud Slough (north), Salt Slough, and the San Joaquin River upstream of the Merced River. In addition, the critical year selenium objective (8 µg/L) for the San Joaquin River downstream of the Merced River was disapproved.

The U.S. EPA approved the water quality objectives for molybdenum and approved the 5 µg/L monthly mean selenium objective in the San Joaquin River downstream of the Merced River. In addition, the U.S. EPA approved the 2 µg/L monthly mean selenium objective for the water delivered to wetland areas within the Grassland watershed.

According to Federal Regulations, a water quality objective adopted by the Regional Board and approved by the State Water Board remains in effect, even though disapproved by U.S. EPA, until the State revises it or U.S. EPA promulgates a rule that supersedes the State water quality objective (40 CFR 131.21 (c)). To date, the U.S. EPA has not promulgated water quality objectives for boron, however in December 1992, the U.S. EPA promulgated a 5 µg/L, 4-day average selenium water quality criteria for all of the water bodies (except wetlands) that were covered by the 1988 Regional Board Basin Plan Amendment. This promulgation also superseded the 5 µg/L monthly mean selenium objective originally approved by U.S. EPA for the San Joaquin River downstream of the Merced River. Regional Board counsel has interpreted the U.S. EPA promulgation of a selenium water quality criteria as effectively preempting the water quality objectives adopted by the Regional Board and approved by the State Water Board. Based on this interpretation, the Regional Board, in December 1994, deleted from the Basin Plan all water quality objectives for selenium that were superseded by the U.S. EPA promulgation.

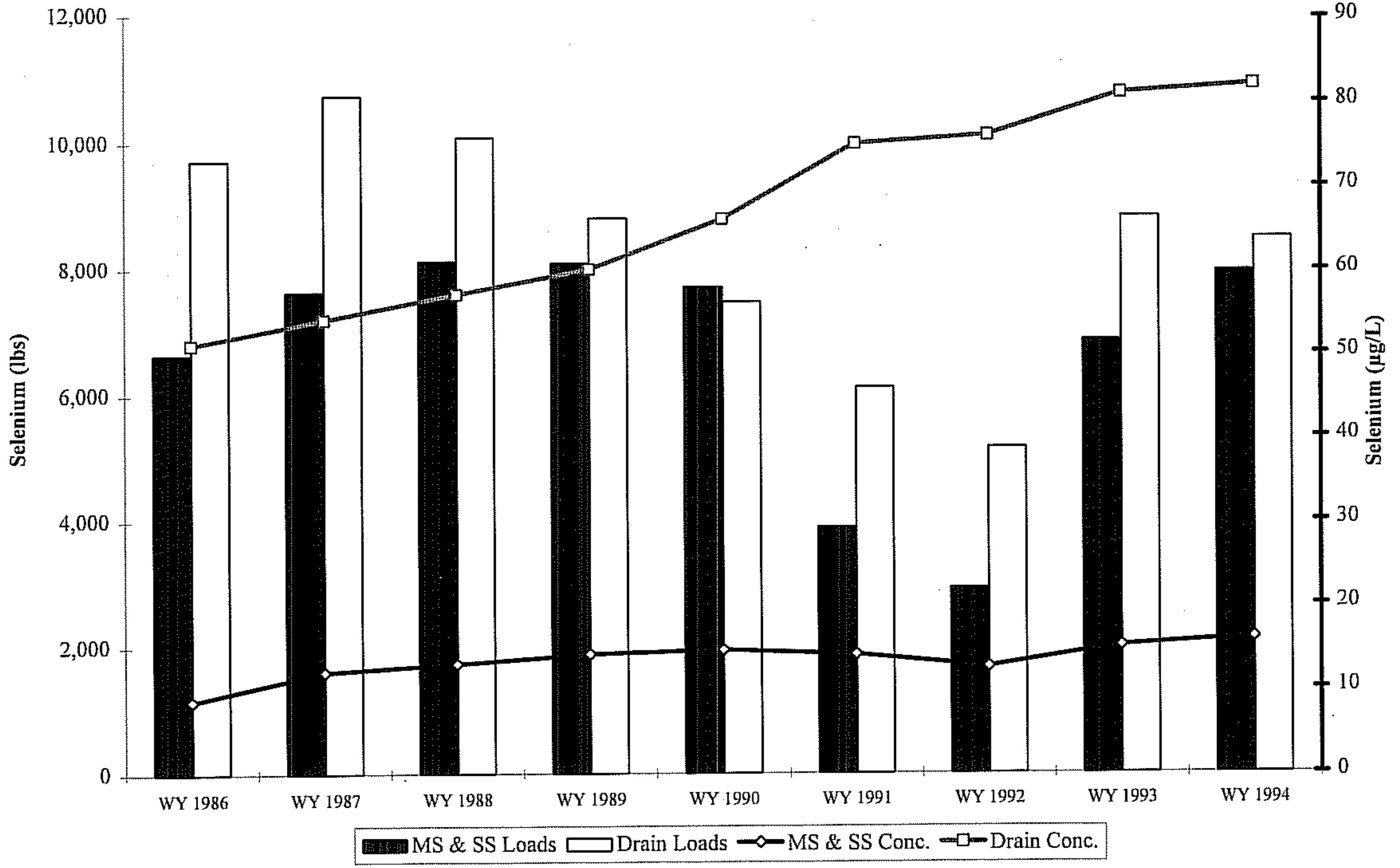
Need for a Revision to the Basin Plan

The Regional Board recognized that the 1988 Basin Plan Amendment was a first step in efforts to control agricultural subsurface drainage and that a revision would be needed as new information became available. Developing new information for the revision was to focus on the adequacy of the water quality objectives to protect beneficial uses and whether the implementation plan was adequate to meet objectives on a continuous basis. The need for this review was based on testimony received in 1988 that there was a lack of a strong understanding of the relationship between dilution flows and discharge especially in the effluent-dominated water bodies.

The 1992 promulgation of more stringent water quality criteria by the U.S. EPA again raised a question regarding the adequacy of the previously adopted water quality objectives and the implementation plan outlined in the Basin Plan. The U.S. EPA promulgation of the national water quality criteria, however, did not include an evaluation of the means of compliance or the cost of compliance, both requirements under State law.

Under the 1988 Basin Plan Amendment, the Regional Board emphasized on-farm water conservation measures as the primary method for meeting water quality objectives and reducing pollutant loads. Studies conducted for the Regional Board (CVRWQCB, 1994) show that irrigation efficiency has improved in the Drainage Study Area and the Regional Board hoped this improvement would translate into a load reduction in the discharge. As shown in Figure 2, selenium loads decreased significantly through water year (WY) 1992, but increased in WY 1993 and remained elevated in WY 1994. The increase in load in WYs 1993 and 1994 occurred despite continuing increases in irrigation efficiency.

Figure 2
Annual Selenium Loads and Concentrations for Drains and Sloughs



An increase in irrigation efficiency can result in a reduction in high quality surface runoff (tail water) and/or poorer quality deep percolation (tile water). The drought and restrictions in water supply since 1988 prompted adoption of farm water conservation measures to minimize the discharge of the high quality tail water and operational spills. Previously, these better quality flows served to dilute the agricultural subsurface drainage flows. Discharge from the Drainage Study Area is now dominated by poor quality tile water, thereby raising the concentration of drainage discharges (Figure 2). Although loads decreased significantly by WY 1992, the increases in effluent concentration combined with the lack of dilution flow in the sloughs resulted in little change in water quality in the sloughs. For example, when the poor quality drainage water is present in Salt Slough, selenium levels are twice as high as the Regional Board adopted monthly mean objective. In Mud Slough (north), selenium levels are 3-5 times higher than the objective when the drainage is present.

In contrast, water quality in the San Joaquin River downstream of the Merced River improved dramatically in response to the load reductions. For example, the large selenium load reductions in WY 1992 resulted in only one violation of the Regional Board adopted monthly mean water quality objective for selenium in the River. This single violation was a significant improvement in water quality even though WY 1992 was the sixth consecutive critically-dry year. The increase in selenium loads to the San Joaquin River in WYs 1993 and 1994 led to an increased number of violations. For example, in WY 1994, the Regional Board adopted 8 µg/L monthly mean selenium water quality objective was exceeded three out of twelve months downstream of the Merced River and the 10 µg/L objective upstream of the Merced River was exceeded in seven out of twelve months.

Failure to meet water quality objectives for selenium and other constituents has led the State of California to list the lower reach of the San Joaquin River as a water quality limited segment as required by the Federal Clean Water Act (Title III, Section 303(d)) and its implementing regulations (40 CFR Ch.1, Subchapter D, Section 130.7). The Regional Board, in November 1991 adopted a Water Quality Assessment that included a description of 130 miles of the San Joaquin River that are impaired and listed that segment in accordance with Section 303(d) of the Clean Water Act. In addition to listing a water body, Federal regulations require the calculation of a "Total Maximum Daily Load" (TMDL) for the listed water body. The TMDL is then apportioned to point sources, non-point sources, and a margin of safety. The TMDL is a load based objective which is designed to attain and maintain the numeric concentration-based water quality objective (see Karkoski, 1994 for a more thorough discussion).

In the 1988 Basin Plan Amendment, the Regional Board identified selenium as the highest priority for action on the lower reach of the San Joaquin River. Under the direction of the State Water Board staff, Regional Board staff have developed a TMDL workplan for the highest priority water bodies in the Region with U.S. EPA approving the development of a TMDL for selenium as the highest priority for the San Joaquin River. This TMDL may become a part of the implementation plan for controlling subsurface agricultural drainage.

Other Developments Affecting Subsurface Drainage

In September 1990, one year after the State Water Board approved the Basin Plan Amendment for controlling subsurface drainage, the San Joaquin Valley Drainage Program (SJVDP) completed their recommended Management Plan (SJVDP, 1990). The plan concentrated on implementation of in-valley management measures through the year 2040. Specific actions were presented on a watershed basis with all of the Drainage Study Area being within the zone called the Grassland watershed. The State Water Resources Control Board was a signatory to the 1991 Memorandum of Understanding (MOU) with 7 other Federal and

State agencies for implementation of the recommended plan. This MOU stated that the Management Plan would be used as a guide for remedying subsurface drainage and related problems. The recommendations of the SJVDP Management Plan for the Grasslands watershed included:

1) Source control for drainage reduction at the farm level;

2) Development of areas for recycling drainage water on more salt tolerant crops;

3) Use of evaporation ponds (120 acres) and solar ponds (130 acres) for final disposal of the unusable drainage water along with mitigation habitat to compensate for any unavoidable losses;

4) Pumping the semiconfined aquifer to control the water table under 10,000 acres of land;

5) Retiring 3,000 acres of irrigated agricultural land;

6) Discharging good quality (low selenium) drainage to the wetlands and poor quality drainage to the San Joaquin River while meeting water quality objectives;

7) Establishing an additional firm water supply of 129,000 acre-ft (total 180,000 acre-ft) for fish and wildlife purposes (mainly water for wetlands); and

8) Establishing an additional water supply of 20,000 acre-ft in the Merced River to prevent straying of salmon into Salt Slough and Mud Slough (north) during the fall migration run.

The basis for the SJVDP recommendations was the need to meet water quality objectives established in the 1988 Regional Board Basin Plan amendment. The SJVDP plan concludes that objectives in the San Joaquin River downstream of the Merced River can be met through the series of actions listed above. In order to meet objectives in the effluent-dominated sloughs and the Grassland wetlands however, the SJVDP Plan recommended that the poor quality subsurface drainage be conveyed through a bypass to a point on the San Joaquin River downstream of the Merced River. The SJVDP plan specifically identified a portion of the former San Luis Drain as one component of this bypass plan. This is consistent with the Regional Board acknowledgment in the 1988 Basin Plan amendment that the Zahm - Sansoni Plan, a similar proposal, appeared to be consistent with long-term water quality protection needs on the San Joaquin River, tributary sloughs and the adjacent wetlands.

In 1992, the Central Valley Project Improvement Act (CVPIA) was signed into Federal law. CVPIA provided for 180,000 acre-feet of water for wetlands in the Grasslands watershed, one of the implementation steps of the SJVDP Plan (see step # 7 above). This included water for development of the new state and Federal refuge lands as mitigation for Kesterson Reservoir impacts as required under Section E of Regional Board Order #87-149. Unfortunately, many of the channels used to deliver wetland supplies are also used to convey drainage water.

This shared conveyance system has led to restrictions in the timing of water deliveries to certain wetland areas due to the presence of selenium in the drainage water. These restrictions have occurred with the existing 51,000 acre-feet of delivered supply and will be compounded when the new supplies under CVPIA are delivered in the next few years. This shared conveyance system raises the likelihood for violations of the water quality objective for wetland supplies. Optimal wetland habitat development will not occur and beneficial use impacts will continue if a conveyance system free of high selenium levels is not available.

In addition to restricting wetland water deliveries, the current shared drainage conveyance system is directly impacting the Los Banos Wildlife Management Area (LBWMA). The drainage is conveyed through Mud Slough (south), which provides water for wildlife habitat within the LBWMA. This flow is then diverted to Salt Slough where beneficial use for the San Luis National Wildlife Refuge and the new refuge lands is being directly impacted.

In summary, several developments since the State Water Board approved the existing Basin Plan Amendment in 1989 require a reevaluation of the Regional Board agricultural subsurface drainage policies and regulations:

1) Although water conservation measures have been implemented, selenium loads are at the same level as in 1989;

2) Water quality in Mud Slough (north), Salt Slough, and the San Joaquin River upstream of the Merced River does not improve in response to pollutant load reductions;

3) Regional Board selenium water quality objectives for the San Joaquin River and sloughs are currently being exceeded at the same rate as in 1989;

4) The U.S. EPA promulgation of a national selenium criteria for the sloughs and San Joaquin River necessitates the Regional Board to consider whether an implementation plan can be developed to meet these criteria;

5) Federal law and regulations require the development of a TMDL (load based water quality objectives) for selenium in the San Joaquin River; and

6) Completion of the SJVDP Management Plan requires a reassessment of the Regional Board subsurface drainage policies and implementation strategy in the Basin Plan and to evaluate whether the SJVDP conclusions are adequate to meet the new U.S. EPA promulgated water quality objectives.

PART II BENEFICIAL USES

Introduction

Proposed beneficial uses for the water bodies in the Grassland watershed (e.g. Mud Slough (north), Salt Slough, and the wetland supply channels) are presented in this section. These proposed uses were derived from an assessment of past, present, and future (potential) uses of these water bodies. This analysis is presented in more detail in an another staff report (CVRWQCB, 1995a) and only the highlights are presented here.

Beneficial uses are the basis for regulation of water quality. This formal recognition allows the uses to be protected by regulatory activities. The basin plan divides the surface water system of a basin into specific surface water bodies and identifies existing and potential beneficial uses for each water body. Not all surface water features are formally identified. For the Grassland watershed, none of the water bodies have been specifically listed in the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan) (CVRWQCB, 1995b) nor have beneficial uses been formally identified through the process of a survey or assessment. Rather, the Basin Plan assumes beneficial uses for a segment of the San Joaquin River (Sack Dam to the mouth of the Merced River) apply to several of the Grassland watershed channels including Mud Slough (north) and Salt Slough. The Basin Plan states that "the beneficial uses of any specifically identified water body generally apply to its tributary streams." This process provides the means of regulating unlisted water bodies and for the protection of downstream water uses until "on a case-by-case basis" beneficial uses can be evaluated (CVRWQCB, 1995b). In order to replace the assumed beneficial uses, the regional board may perform a survey and assessment of all past, present, and probable beneficial uses and amend the Basin Plan (Jennings, 1994).

The assumed beneficial uses for water bodies in the Grassland watershed are likely not appropriate because of the differences in geology and hydrology of the watersheds that provide the primary source of flow for the San Joaquin River, as compared to the watershed that drains into Mud Slough (north) and Salt Slough and other Grassland channels. In addition, the present physical and chemical character of the sloughs has developed as a result of an evolution of the hydrology from flooding and natural fluvial processes to a managed, and effluent-dominated system. Current uses of Mud Slough (north) and Salt Slough have developed from discharges to the sloughs, mainly agricultural and wetland drainage and are, therefore, effluent-dominated water bodies. The beneficial uses of wetland water supply channels are governed by wetland management practices including, water deliveries and drainage of wetlands. These channels are primarily constructed or highly modified natural channels, many of which were constructed to aid in the management of manmade wetlands.

An assessment of beneficial uses of Grassland watershed water bodies is needed in order to regulate discharges that may be impacting these uses. These discharges include but are not limited to agricultural subsurface drainage from the southern portion of the Grassland watershed and wetland drainage. The need to regulate discharges to the Grassland watershed channels are prompted by the following:

- sensitivity of waterfowl to selenium toxicity;
- elevated concentrations of selenium in wetland channels;

- potential for contamination of wetland water supplies with selenium; and

- potential for impairment of downstream beneficial uses.

Factors Influencing Beneficial Uses

The present level of beneficial uses of Mud Slough (north) and Salt Slough were developed as a result of modifications of the natural hydrology. The level of beneficial uses in the wetland channels has developed as a result of the physical characteristics (e.g. channel morphology) of the constructed channels and of wetland management practices.

Mud Slough (north) and Salt Slough along with the remainder of the San Joaquin River Basin have undergone dramatic changes in their hydrology and water quality in the past century, due to agricultural development and alteration of the natural hydrology. In its pristine state, portions of the Grassland watershed (basin trough and rim) were subject to annual flooding from the San Joaquin River followed by drainage, which created a landscape of seasonal and permanent wetlands and upland grassland. These wetlands formed critical habitat for migratory and resident waterfowl. The drainage of flood water was the principal source of flow for Mud Slough (north) and Salt Slough. With the expansion of agriculture, increasing levels of flood control and water diversion were implemented in the region. Alterations to the native environment began in the late 1800s and culminated with completion of most elements of the Central Valley Project (CVP) in the early 1950s. The impacts of the CVP project on the Grassland watershed included:

- cessation of annual flooding of the Grassland watershed basin trough and rim;

- loss of the principal source of natural flow for Mud Slough (north) and Salt Slough;

- introduction of poorer quality water (higher salinity) imported from the Delta to the Grassland watershed;

- increased intensity of irrigation of agricultural land in the western portion of the watershed; and

- alteration and destruction of the natural aquatic habitat.

Construction of Friant Dam and other flood control structures, including those on the westside streams, along with diversions of the upper San Joaquin River to areas outside of the San Joaquin Basin resulted in cessation of annual flooding of the San Joaquin River in the Grassland watershed. This resulted in the loss of the principal source of flow for Mud Slough (north) and Salt Slough and loss of water which created the wetlands. To replace water supplies lost from diversion of the upper San Joaquin River, water was imported to the Grassland watershed from the Sacramento-San Joaquin River Delta via the Delta-Mendota Canal. This replacement water supply is used for agricultural production and to artificially maintain a portion of the former wetlands. These wetlands are maintained for waterfowl habitat in private duck hunting clubs and public wildlife refuges.

Water from the upper San Joaquin River originates in the Sierra Nevada and is of good quality (low salinity, turbidity, alkalinity) due to the geology (mainly granitic) of this mountain range. In contrast, water from the

Delta Mendota Canal is of poorer quality (higher salinity, turbidity, and alkalinity) because it originates in an estuary and because of influences of agricultural return flows.

Water supplies from the Delta-Mendota Canal were also directed to the western portion of the Grassland watershed. This area did not formerly have a surface water supply. This water diversion permitted more intensive irrigation of these lands. Much of this area is now known as the Drainage Study Area and is located on the Panoche alluvial fan. The marine sediment influences on the Panoche alluvial fan soils are reflected in their saline character and elevated trace element concentrations including, selenium. Irrigation of soils in the Drainage Study Area, as a result of water supplies introduced by the Delta-Mendota Canal, has resulted in mobilization of trace elements and salts to the groundwater. Irrigation has also resulted in raising the water table, which has necessitated the installation of subsurface drainage systems. Agricultural subsurface drainage from this area is the principal source of selenium and salts in Grassland watershed waterways. The water quality characteristics of the sloughs is a combination of the chemistry of the soils from which the drainage originates and of the Sacramento-San Joaquin Delta water quality.

The natural hydrology of the Grassland watershed has been altered to serve the needs of the various land uses within the Grassland watershed. Natural channels are interconnected with artificial channels and modified natural channels through diversion structures and gates in order to convey water supplies from the CVP at the upstream end of the watershed to agricultural lands and wetlands. Wastewater (agricultural surface and subsurface drainage, wetland drainage, storm water runoff, and wastewater treatment plant discharges) generated is conveyed to Mud Slough (north) or Salt Slough and then to the San Joaquin River, at the downstream end of the watershed through many of these same channels used also for freshwater deliveries.

The impacts to Mud Slough (north) and Salt Slough of the alteration of the natural hydrology has been the loss of the principal source of natural flow in the sloughs, which has resulted in a profound decrease in flow. Second the water quality characteristics of the sloughs has been greatly altered because, in their present state, the sloughs merely serve as a conveyance system for agricultural and wetland wastewaters to the San Joaquin River. These wastewaters are characterized by elevated trace elements and salt concentrations, turbidity, and alkalinity. Because flows in Mud Slough (north) and Salt Slough now have a different origin from those in the main stem of the San Joaquin River, the sloughs likely support different beneficial uses than the San Joaquin River.

The preceding discussion has demonstrated that the landscape of the Grassland watershed and quantity and quality of water in the sloughs has been greatly altered as a result of hydrological modifications and changing land use practices. These alternations led to changes in the environment and in the level of beneficial uses supported. As an example are the impacts of the hydrological modifications on the fisheries resources of the San Joaquin Valley, including the water bodies of the Grassland watershed. Alteration of the natural hydrology has resulted in the destruction of the natural aquatic habitat, which has been attributed as the principal reason for the disappearance of native fish species from the San Joaquin Basin. The introduction of exotic species has also been credited, to a lesser extent for the changing fish distributions in the San Joaquin Basin. Introduced species have adapted to the altered environment and have flourished, while the native species have not. Additionally, introduced species compete for limited food resources and habitat with the native species and in some limited cases have out competed the native species to the point of elimination (Moyle, 1976).

Unlike Mud Slough (north) and Salt Slough, most of the wetland channels are constructed channels designed for the specific purpose of managing wetlands. The level of beneficial uses in these channels has developed as a result of the water management practices and physical characteristics of the channels. The channels are similar in that they are earthen lined, straight, steep banks and lack the features of natural streams, such as meanders, pools, riffles, shallows, etc. The wetland channels, however, differ in function and physical characteristics, primarily with respect to the quantity and quality of water conveyed and in channel capacity. These factors impact the level of beneficial use attained by the channels. Three general types of channels were identified based on similarities in physical characteristics and wetland management practices: primary, secondary and tertiary channels.

In general, wetland channels decrease in channel capacity, water quantity and quality conveyed, continuity of flow, and channel maintenance from primary to secondary to tertiary channels. That is primary channels are large, convey good quality water continuously, and receive a high level of channel maintenance such that they are void of channel and riparian vegetation. Tertiary channels on the other hand are small, convey a variety of water qualities, are subject to periods of low flow and dryness and are clogged with channel vegetation. These differences in channel characteristics is due to the function of the channel.

The principal function of the primary channels are to convey water supplies to wetlands and agricultural lands. Secondary channels receive water supplies from the primary channels for either conveyance to tertiary channels or for diversions to wetlands. Many of these channels, primarily those in the southern Grassland Water District serve the multiple purpose of conveying wetland water supplies as well as wetland drainage, and agricultural surface and subsurface drainage. Tertiary channels receive wetland water supplies from the secondary channels, which are conveyed to wetlands through diversions and direct discharge. These channels also convey wetland drainage to the secondary channels and some also convey agricultural subsurface drainage. Flow is intermittent in these channels and dependent on wetland management practices. Extended periods of dryness are possible in these channels.

Mud Slough (north) and Salt Slough

Mud Slough (north) and Salt Slough are unlisted water bodies in the Basin Plan. The beneficial uses proposed for the sloughs in this Basin Plan amendment are intended to list these water bodies and to replace the assumed beneficial uses with those derived from a survey and assessment of past, present, and potential uses. Available historic chemical, physical, and biological data was compiled for the assessment. Some of this data dated back to 1938. Land use data (e.g. cropping and tile drainage statistics) were compiled to supplement historical data and to draw inferences regarding probable impacts of land uses on the beneficial uses of the sloughs where historical data was lacking.

Mud Slough (north) and Salt Slough are depicted in Figure 1. Mud Slough (north) originates at Kesterson Ditch[1] and meanders in a northerly direction, through the northern portion of the Grassland Water District to the San Joaquin River at approximately midway between the Highway 140 bridge and the confluence with the Merced River[2]. Mud Slough (north) receives wetland drainage from surrounding duck clubs and wildlife reserves, subsurface drainage and tail water from upslope agriculture, operational spills and storm runoff.

[1]At SW 1/4, NW1/4, NE1/4, Sec 33, T8S, R10E, MDB&M

[2]At NW1/4, NE1/4, NW1/4, Sec 14, T7S, R9E, MDB&M

Mud Slough (north) also receives treated wastewater from the Gustine wastewater treatment plant through Los Banos Creek. The principal tributaries to Mud Slough (north) are Kesterson Ditch, Fremont Canal, Santa Fe Canal, and Los Banos Creek.

Salt Slough originates where Salt Slough Ditch and West Delta Drain meet and discharge through Sand Dam[3]. Salt Slough flows northwesterly and discharges to the San Joaquin River at river mile 129.7[4], about 4 miles upstream of the Mud Slough (north) discharge to the river. The principal tributaries of Salt Slough are Salt Slough Ditch, West Delta Drain, and Mud Slough (south). Sources of flow in Salt Slough include surface and subsurface agricultural drainage, operational spills, wetland drainage, and local runoff.

Table 1 list the definition of beneficial uses that were evaluated for Mud Slough (north) and Salt Slough. This list was selected from the Basin Plan for the Sacramento/San Joaquin River Basin (CVRWQCB, 1995b) and includes beneficial uses of the San Joaquin River for the segment between Sack Dam and the mouth of the Merced River (Table 2), which were assumed for Mud Slough (north) and Salt Slough. This list also includes beneficial uses which are likely to be present. Table 2 summarizes the beneficial uses proposed for the sloughs.

Municipal and Domestic Supply (MUN)

MUN use is not a current or previous use of the sloughs. Numerous factors likely restrict the development of this use. The agricultural and wetland drainage flows contain elevated salinity levels that often exceed Federal and State standards for drinking water. Additionally, these flows may contain pesticides and other contaminants of concern to public health, owing to their agricultural origins, and are not likely to be approved for drinking water supply by the Department of Health.

In the absence of agricultural and wetland discharges, low flow conditions and naturally elevated salinity would restrict the use of the sloughs for MUN. Furthermore, State Water Resources Control Board Sources of Drinking Water Policy (Resolution No. 88-63) exempts water systems designed for the primary purpose of conveying agricultural drainage from drinking water supply considerations. Thus, since this is neither a current or past use and is unlikely to be a future use, MUN is not proposed for designation.

Agricultural Supply (AGR)

Presently, both sloughs are used as a source of water for pasture irrigation and stock watering. Additionally, Mud Slough (north) is used for limited crop irrigation (Pierson et al., 1989a). The use of the sloughs for AGR require exclusion of subsurface drainage, because of its elevated salinity and trace elements may restrict this use. Since one of the sloughs must be conveying subsurface drainage at any given time, it is not presently possible to use the sloughs simultaneously for AGR.

The naturally elevated boron and salinity concentrations (in the absence of subsurface drainage) in Mud Slough (north) limit the use of this water supply to crops that are moderately tolerant of boron and salinity.

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[3]At NW1/4, SE1/4, NE1/4, Sec 21, T9S, R11E, MDB&M

[4]At NE1/4, NE1/4, SW1/4, Sec 29, T7S, R10E, MDB&M

Removal of subsurface drainage discharges to the sloughs would not enhance AGR uses of the sloughs. It would however, permit the simultaneous use of the sloughs for agricultural uses.

Regardless of limitations in using water from either slough for irrigation or stock watering, AGR beneficial uses are proposed for Mud Slough (north) and Salt Slough. These uses may be achieved on a seasonal basis and irrigation may be limited to more tolerant crops because of existing and historical water quality.

Industrial Service (IND) and Industrial Process Supply (PROC)

Neither slough is utilized for these uses and there is no record that they have been utilized for these purposes, as there are no industrial facilities adjacent to the sloughs (Pierson et al., 1989a and b). Water quality conditions, such as high turbidity, salinity, and alkalinity may restrict industrial uses requiring certain water quality. Eliminating discharges (e.g. wetland and agricultural drainage) which contribute to these water quality conditions, would result in insufficient flow in the sloughs to support the industrial uses. Due to the irregular supply of water in the sloughs and the fluctuating water quality, with or without discharges, industrial uses are not likely to be realized. Thus, since IND and PROC uses are not current or past uses and do not have the potential to be realized, they are not proposed for either slough.

Water Contact (REC-1) and Non-Contact Recreation (REC-2)

Both types of recreational uses have occurred on Mud Slough (north) and Salt Slough, although some characteristics may deter some users. These characteristics include turbid waters, muddy stream bed, low flow conditions, and potential presence of vector and nuisance organisms. Incidental ingestion of water with selenium concentrations above the California Maximum Contaminant Level (MCL) but below the Federal MCL are not expected to cause a public health concern, due to the short-term of such exposure.

No additional recreational benefits are expected to be achieved by restricting subsurface drainage discharges. While the water quality would improve by eliminating such discharge, the present recreational opportunities have developed as a result of the effluent-dominated flow characteristics of the sloughs. In the absence of these discharges, flow would be reduced and would affect the quality of recreational uses. Thus, there is no net benefit to recreational uses of the sloughs by eliminating this discharge.

Although there are no public access areas with accommodations for swimmers or bathers along either slough, local residents have been known to wade in both sloughs while scavenging for frogs and clams. This activity does represent contact recreation. Based on these evaluations both REC-1 and REC-2 uses are proposed for Mud Slough (north) and Salt Slough.

Warm Freshwater Habitat (WARM)

The aquatic life beneficial uses for the sloughs were inferred from an evaluation of fishery resources data, due to the unavailability of biological data on other organisms. A direct correlation between the type of fishery present (e.g. warm or cold) and the type of aquatic ecosystem supported was assumed. Water temperature data was also used in the evaluation.

The evaluation showed that Salt Slough has a diversity (number of species) of fish species similar to other locations observed throughout the San Joaquin Valley (Saiki, 1984). The association of fish in the slough were similar to other sites along the lower San Joaquin River. The fish in Salt Slough were observed to fluctuate in species composition and abundance from sampling to sampling, such that a species may disappear from the association while others not formerly present may become abundant. The sparse data for Mud Slough (north) also show similar trends in fish distributions. During low flow conditions in Mud Slough (north), however, species diversity and abundance may be limited to a few resistant species. The association of fish found in Mud Slough (north) and Salt Slough resemble the association of minnows described by Brown (unpublished data). This fish association is positively correlated with water quality parameters identified with agricultural discharges (elevated specific conductance, hardness, and nutrients). The most common fish species in the sloughs were fathead minnow (*Pimephales promelas*), common carp (*Cyprinus carpio*), inland silverside (*Menidia beryllina*), and Sacramento blackfish (*Pogonichtys macrolepidotus*). These fish species are associated with a warm water ecosystem.

It is not known, however, if removal of agricultural discharges would result in an enhancement (greater biodiversity, greater abundance of native fish species, and biomass) of the aquatic beneficial uses of the sloughs. Removal of these discharges would remove a source of flow to the sloughs, since these are effluent-dominated water bodies. The resultant flow condition may negatively impact the aquatic resources. Additionally, there may not be a significant improvement in overall water quality, particularly in Mud Slough (north). Historic conditions (pre-subsurface drainage discharges) in Mud Slough (north) show seasonal low flow and high salinity and boron concentrations.

WARM beneficial uses are proposed for Mud Slough (north) and Salt Slough based on the presence of a warm water fishery.

<u>Cold Freshwater Habitat (COLD)</u>

The association of fish reported for Mud Slough (north) and Salt Slough do not fall into the category of species generally associated with cold water fisheries (e.g. salmon, sturgeon). Migrating adult chinook salmon (*Oncorhynchus tshawytscha*) have been known to stray into Salt Slough and other non-origin streams, due to improper imprinting of home streams or because of the lack of attractive flows in the east side San Joaquin River tributaries (CDFG, 1987). Straying is an aberration as neither slough has the required substrate for spawning or the required environment for development of eggs and young (SWRCB, 1987). Therefore, cold fresh water habitat uses are not currently being attained for Mud Slough (north) or Salt Slough. Evaluation of current and historic temperature data show that temperature profiles for the sloughs have not been greatly affected by past modifications of basin hydrology (CVRWQCB, 1995a). The temperature profiles are consistent with the description of San Joaquin Valley floor water bodies as warm, sluggish, meandering sloughs, oxbow lakes and backwaters (Moyle, 1976). The maximum temperature of 56.5 °F recommended by the National Marine Fisheries Service, between mid-April and the end of September for chinook salmon, a common cold water species native to the San Joaquin River is exceeded in both sloughs in all but the winter months (mid-November to mid February) (CVRWQCB, 1995a).

The inability of Mud Slough (north) and Salt Slough to support a common California cold water species indicates that cold water habitat is not a potential use of Mud Slough (north) and Salt Slough nor has either slough supported such use. Thus, since COLD is not a current or past use and does not have the potential to be realized, it is not proposed for the sloughs.

Migration of Aquatic Organisms (MIGR)

In California, the migratory fish species are principally steelhead and rainbow trout (*Oncorhynchus mykiss gairdneri*), white sturgeon (*Acipenser transmontanus*), American shad *(Alosa sapidissima)*, and chinook salmon. As noted earlier, chinook salmon are known to occasionally stray into Salt Slough, however, this is an aberration due to lack of appropriate habitat and environment for egg development (pre-spawning), spawning, juvenile development, and migration of smolts. The 54 °F maximum temperature required prior to and during seaward migration of smolts (DWR, 1988) is exceeded during the height of the emigration period (March to June). Additionally, there are no natural tributaries to Mud Slough (north) and Salt Slough that lead to areas suited for cold water spawning. Therefore, migration is not a beneficial use of Mud Slough (north) and Salt Slough for cold water and anadromous fish species.

Another species known to migrate to spawning sites is stripped bass *(Morone saxatilis)*. Stripped bass generally reside in estuaries and in sea water during a portion of their adult phase and migrate in the spring to large rivers to spawn. In the San Joaquin River, stripped bass commonly spawn from Venice Island to Antioch (Moyle, 1976). Stripped bass have been identified in Mud Slough (north) (Saiki, unpublished data), however, it is unlikely that their presence was due to migration. More likely they, entered Mud Slough (north) via the irrigation delivery channels that imported water from the Delta.

Salt Slough and Mud Slough (north) do not provide the necessary habitat for successful spawning of stripped bass. Successful spawning is dependent on the interaction of three factors: temperature, flow, and salinity. Stripped bass generally prefer to spawn in large rivers that have optimum spawning flows. Sufficient flow is required to maintain eggs and larvae suspended but not too high that eggs are washed into quiet waters. Mud Slough (north) and Salt Slough, with their fluctuating flows, are not suitable habitat for such spawning. Additionally, the salinity level in the sloughs is too great to permit successful spawning. Because of the narrow tolerance of stripped bass to the three factors, there are only two principal spawning areas in the Delta. These are the Sacramento River from Isleton to Butte City and the San Joaquin River and its sloughs from Venice Island to Antioch (Moyle, 1976). As a result, MIGR is not a proposed beneficial use for either slough.

Spawning, Reproduction, and/or Early Development (SPWN)

Mud Slough (north) and Salt Slough present an environment unfavorable for spawning of cold water species. As was previously noted, water temperatures in the sloughs are greater than the 56.5 °F most of the year except for the winter season. Temperatures exposures of adult chinook salmon and eggs above this threshold will result in greater than normal losses and abnormalities of young fish. These temperatures are exceeded in the sloughs during the adult immigration period (mid-July through November) (DWR, 1988). Water temperatures from 55 to 57.5 °F, though producing low egg mortality, results in sac-fry mortalities greater than 50% (DWR, 1988). These temperatures are exceeded in the sloughs during a portion of the incubation period.

In addition to the temperature restrictions on reproduction and early development, the sloughs do not possess the appropriate substrate required by many cold water species for spawning. The sloughs generally contain fine sediments rather than the gravel beds required for spawning. The beneficial use of cold water spawning is, therefore, not proposed for either Mud Slough (north) or Salt Slough because of the conditions for spawning, reproduction and early young rearing are not present.

Mud Slough (north) and Salt Slough have been identified as a warm water habitat due to the presence of a variety of warm water fish species. Water temperatures and substrate, in Mud Slough (north) and Salt Slough are, generally suitable for spawning of many warm water species present in the Grassland watershed (USEPA, 1972), therefore warm water SPWN beneficial use is an existing beneficial use of the sloughs.

Wildlife Habitat (WILD)

Presently, wetlands are artificially maintained as seasonal fresh water wetlands, permanent alkali marshes, and grassland. These wetlands are important habitat for migratory waterfowl. Prior to 1985, Mud Slough (north) and Salt Slough were a source of water for maintenance of these wetlands. Since 1985, selenium laden subsurface drainage flows from the southern portion of the Grassland watershed have not been used for wetland water supply in the Grassland watershed. The result has been that these drainage flows have been diverted away from the wetlands causing an increase in direct discharge of these flows to Mud Slough (north) and Salt Slough. The sloughs are now used as the principal conveyance of subsurface drainage to the San Joaquin River. As long as this practice continues the water quality of the two sloughs will not be acceptable for wetlands use or for use by other wildlife habitat in the vicinity of the two sloughs. Elimination of subsurface drainage discharges would enhance the wildlife habitat beneficial uses and would permit the use of both sloughs for wetland supply. Wildlife habitat beneficial uses (WILD) are proposed for both sloughs.

Commercial and Sports Fishing (COMM)

Sport fishing is a present and past use of both Mud Slough (north) and Salt Slough, although this use is only practiced to a limited extent due to the inaccessibility of the sloughs to the public. The quality of this use may be limited in Mud Slough (north) due to intermittent and low flow conditions, however, it does not preclude the attainment of this use. Based on this observation, the sport fishing beneficial use (COMM) is proposed for both Mud Slough (north) and Salt Slough.

Preservation of Biological Habitats of Special Significance (BIOL)

The San Luis National Wildlife Refuge has riparian water rights to Salt Slough. These rights are exercised only on a limited basis due to poor water quality in Salt Slough. Salt Slough has been used occasionally during drought periods to supply summer irrigations to this refuge when it carries of operational spills and agricultural surface drainage of adequate quality for wetland use. There is no record that Mud Slough (north) has been utilized to supply any of the wildlife refuges or management areas with water, including Kesterson National Wildlife Refuge, which it traverses. Kesterson National Wildlife Refuge is currently supplied by the Santa Fe Canal and San Luis Canal. It is unlikely that Mud Slough (north) will supply Kesterson National Wildlife Refuge with water since there is already a water supply system, and because of intermittent low flow and poor quality conditions in Mud Slough (north).

The beneficial use of preservation of biological habitats of special significance (BIOL) is proposed for Salt Slough based on the existence of this use. This use is, however, not proposed for Mud Slough (north) based on the absence of past, present or potential use.

TABLE 1: DEFINITION OF BENEFICIAL USES

Beneficial Use	Abbreviation	Definition
Municipal and Domestic Supply	MUN	Uses of Water for community, military, or individual water supply system including, but not limited to, drinking water supply.
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well protection, or oil well pressurization
Industrial Process	PROC	Use of water for industrial activities that depend primarily on groundwater.
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Commercial and Sports Fishing	COMM	Uses of water for commercial or recreational fishing or recreational collection of fish, shellfish, or other organisms including, but not limited to uses involving organisms intended for human consumption or bait purposes.
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including vertebrates.
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.
Wildlife Habitat	WILD	Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g. mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food resources.
Preservation of Habitats of Special Significance	BIOL	Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance, where the preservation or enhancement of natural resources requires special protection.

Table 2. Designated and Proposed Beneficial Uses

Surface Water Body	Water Use					Recreational				Fresh Water Aquatic Life						Wildlife	
	MUN	IND		AGR[1]		REC-1	REC-2		COMM	WARM[2]	COLD	MIGR		SPWN		WILD	BIOL
	Municipal and Domestic Supply	Industrial Process	Industrial Service	Irrigation	Stock Watering	Contact	Non-contact	Canoeing	Sports Fishing	Warm Water Habitat	Cold Water Habitat	Warm Water Species	Cold Water Species	Warm Water Species	Cold Water Species	Wildlife Habitat	Preserve
San Joaquin River Mendota Dam to Sack Dam	■	■		■	■	■	■	■		■		■	■	■	■	■	
San Joaquin River Sack Dam to mouth of the Merced River	■	■		■	■	■	■	■		■		■	■	■	■	■	
Salt Slough				●	●	●	●		●	●				●		●	●
Mud Slough (north)				●	●	●	●		●	●				●		●	
San Joaquin River mouth of the Merced River to Vernalis	■	■		■	■	■	■	■		■		■	■	■	■	■	
Wetland water supply channels[3]				●	●					●						●	●

■ designated beneficial use ● proposed beneficial use

[1] Uses of Mud Slough (north) and Salt Slough and the wetland supply channels may be limited at times to salt and boron tolerant crops. Also intermittent low flow conditions may limit this use.
[2] Wetland channels can sustain aquatic life but may not be suitable for rearing and propagation.
[3] Wetland water supply channels for which beneficial uses are being proposed are defined on Tables 1 and 2.

Grassland Wetland Channels

Table 1 lists the definition of beneficial uses that were evaluated for wetland channels. Beneficial uses evaluated included these designated for the segment of the San Joaquin River from Sack Dam to the mouth of the Merced River and assumed to Mud Slough (north) and Salt Slough. Additionally, uses with the potential to be present were also evaluated. All of the wetland channels listed in Tables 3 and 4 were considered together, because of the similarity between these water bodies and their uses. Table 2 summarizes the beneficial uses proposed for the wetland channels. The hierarchy of channels are listed in Tables 3 and 4 along with function and locations of some of the more important channels wetland and are depicted in Figures 3a-3c.

Assessment of beneficial uses requires evaluation of past, present, and potential uses of the water body. Development of most of the water conveyance infrastructure pre-dates the formation of the Grassland Water District (GWD) in 1953. (The GWD was formed to manage 50,000 acre-feet water supply granted for the wetlands and is the largest entity for management of wetlands within the Grassland watershed.) Because most of the infrastructure was in place prior to the formation of the GWD, there is little historic information on the wetland channels. However, these channels were constructed and historically used for the same purpose for which they are used presently. This is evidenced by the stability of land use practices in the GWD. The total wetland area in the GWD has remained stable since 1957 at approximately 47,000 acres (SJVDP, 1990). Thus, it is reasonable to assume that the past uses of these channels are the same as the present.

Municipal and Domestic Supply (MUN)

MUN use is not a current or past use of the wetland channels. Numerous factors likely restrict the development of this use for the secondary and tertiary channels. The agricultural and wetland drainage flows contain elevated salinity levels that often exceed Federal and State standards for drinking water. Additionally, these flows may contain pesticides and other contaminants of concern to public health, due to their agricultural origins, and are not likely to be approved for drinking water supply by the Department of Health.

The State Water Resources Control Board Sources of Drinking Water Policy (Resolution No. 88-63) exempts water systems designed for the primary purpose of conveying agricultural drainage from drinking water supply considerations. Thus, since this is neither a current or past use and is unlikely to be a future use, MUN is not a proposed use.

Agricultural Supply (AGR)

Presently, the wetland channels are used as a source of water for pasture irrigation and/or stock watering. Many of the wetlands served by these channels are used for seasonal wetlands, which are drained in the spring and then managed for natural pastures for livestock feed and wildlife habitat.

Since flow in the channels is artificial, there may be periods of dryness in the channels. This is particularly true in the tertiary channels. The water quality may also limit the use to crops that are tolerant of elevated salinity and trace element concentrations, primarily boron and selenium. Otherwise, full AGR will require exclusion of subsurface drainage.

Regardless of limitations in using water from the wetland channels for irrigation or stock watering, AGR beneficial uses are proposed. These uses may be achieved on a seasonal basis and the use for irrigation may be limited to more tolerant crops because of existing water quality.

Industrial Service (IND) and Industrial Process Supply (PROC)

None of the wetland channels are utilized for these uses and there is no record that they have been utilized for these purposes, as there are no industrial facilities adjacent to the channels. The land that borders these channels is either agricultural or wetland. Water quality conditions, such as high turbidity, salinity, and alkalinity may restrict industrial uses requiring certain water quality. The irregular nature of flow in the secondary and tertiary channels makes this an unreliable source. Due to the irregular supply of water in the wetland channels and the fluctuating water quality, with or without discharges, these uses are not likely to be realized. Thus, since IND and PROC uses are not current or past uses and do not have the potential to be realized, they are not proposed for the wetland channels.

Water Contact (REC-1) and Non-Contact Recreation (REC-2)

REC-1 and REC-2 are not present or past uses of most of the wetland channels. These channels are on private property and are not accessible for public use. Furthermore, the channels were designed for the purpose of conveying water and do not have characteristics suitable for REC-1. The channels generally have steep banks that make swimming dangerous. The tertiary channels are generally too small and flow too shallow for REC-1. Additionally, channel vegetation and the potential presence of vector organisms may deter some users.

Based on this evaluation, REC-1 and REC-2 are not proposed for any of the wetland channels.

Warm Freshwater Habitat (WARM)

Water supplies for the Grassland watershed wetlands are derived from the Sacramento-San Joaquin Delta through the Delta-Mendota Canal, and are then distributed to wetlands through the hierarchy of channels. Fish residing in the Delta have been known to migrate to Grassland watershed channels through the Delta-Mendota Canal (CVRWQCB, 1995a). The types of fish species that generally migrate through the Delta-Mendota Canal are associated with warm aquatic environments (e.g. stripped bass, channel catfish). The Delta-Mendota Canal itself is classified for WARM beneficial uses in the Basin Plan (CVRWQCB, 1995b). The fish species commonly caught in the primary channels are stripped bass, channel catfish (*Ictalurus punctatus*), large mouth bass (*Micropterus salmoides*), and carp (Tim Poole, personal communications). These species are associated with warm water aquatic environments.

The habitat of the wetland channels, however, is not conductive to the long-term residence, including rearing and propagation of fish species. As was previously noted, most of the wetland channels are either constructed or highly modified streams and do not possess natural features, such as pools, riffles, aquatic vegetation, etc., which form important fish habitat for the various life stages. Furthermore, the secondary and especially the tertiary channels experience periods of dryness or very low flow. The wetland channels are only capable of temporarily sustaining aquatic life but are not capable of preserving or enhancing it.

The aquatic resources of Los Banos and Garza Creek have not been evaluated. Some segments of these channels which have not been extensively modified may have some features similar to natural streams. These streams, however, like the other secondary and tertiary wetland channels, are subject to frequent periods of dryness or low flow. Thus, these streams, as with the other wetland channels, are only capable of temporarily sustaining warm water aquatic species but not of preserving and enhancing it. Thus, only limited WARM uses are proposed for wetland channels.

Cold Freshwater Habitat (COLD)

Water temperature data is not available for wetland channels. However, water bodies of the San Joaquin Valley floor are generally associated with warm aquatic habitats. This is due to the warm summers and mild winters of the San Joaquin Valley. Water temperatures for Mud Slough (north) and Salt Slough were found to be correlated with air temperature and season (CVRWQCB, 1995a). This type of correlation is also expected for the wetland channels. Additionally, the wetland channels may be highly sensitive to air temperature and solar radiation due to the lack of riparian vegetation along primary channels which shades streams and ameliorates the effects of solar radiation on water temperature.

The fish species generally found in the wetland channels are not associated with cold water environments. Because of warm water temperature and the absence of fish species associated with cold water environments, COLD uses are not proposed for the wetland channels.

Migration of Aquatic Organisms (MIGR)

In California, the migratory fish species are principally steelhead, rainbow trout, white sturgeon, American shad, and chinook salmon. These species are generally not found in the wetland channels. They are also associated with cold water environments. Because of the warm water environment of the wetland channels, the migration of these species through these channels would not be supported (see discussion for Mud Slough (north) and Salt Slough). Additionally, there are no tributaries to these channels that would be appropriate spawning areas.

Stripped bass are also known to migrate to spawning sites. As was noted in the discussion for Mud Slough (north) and Salt Slough, the Grassland wetland channels do not provide the appropriate environment for the spawning of this species and their presence in the wetland channels is due to straying into the Delta-Mendota Canal rather than migration. As a result, MIGR is not a proposed beneficial use for wetland channels.

Spawning, Reproduction, and/or Early Development (SPWN)

The wetland channels present an environment unfavorable for SPWN of cold water species. First, temperatures are unfavorable for all activities of cold water species. Second, the substrate in the channels is inappropriate for spawning of cold water species, which require gravel beds.

The environment in the wetland channels is also inappropriate for spawning of warm water species. The habitat created by the alteration of natural streams or the constructed channels is unsuitable for the long-term residence of fish species. The channels are straight with steep banks and scarce aquatic vegetation. Aquatic life generally requires diverse habitats to complete their life cycles. For example, juveniles may seek refuge from predatory fish in shallow stream banks having rooted vegetation, while adult fish may reside in deeper water. Based on this analysis, SPAWN beneficial uses are not proposed for the wetland channels.

Wildlife Habitat (WILD)

The wetland channels were historically and to this day used in-part to convey water supplies to the wetlands. This function is likely to continue in the future due to policies to preserve wetlands. Some of the channels may also be used to convey agricultural subsurface drainage. The use of the channels for wetland water supply may be limited when this type of flow is present in the channel due to elevated selenium concentrations in the agricultural drainage. To avoid contamination of wetland water supplies, agricultural subsurface drainage from the southern Grassland watershed have been segregated since 1985, in order to have water of adequate quality for the wetlands. As long as the wetland channels are used for conveyance of subsurface drainage, agricultural subsurface drainage will have to continue to be segregated from wetland water supplies. With the increase wetland water supply through CVPIA more careful management of these flows will have to occur. Wildlife habitat beneficial uses (WILD) are proposed for wetland supply channels.

Preservation of Biological Habitats of Special Significance (BIOL)

The Grassland watershed contains the largest continuous wetland area in California (SJVDP, 1990). This wetland area is composed of private and public wetlands, both of which are managed wetlands that are supplied by water from outside the watershed. Numerous wetland channels supply public refuges or wildlife management areas with wetland water supplies (CVRWQCB, 1995a). The distribution of water is done through a complicated array of sloughs, canals and drains. Boundary Drain and the San Luis Canal supply the Los Banos Wildlife Management Area. The San Luis Wasteway supplies the Volta Wildlife Management Area. Eagle Ditch, Santa Fe Canal and the San Luis Canal supply the Kesterson National Wildlife Refuge. Canals within the San Luis Canal Company, a private irrigation company, supply water to the San Luis National Wildlife Refuge. There are numerous canals, drains and sloughs that will also supply the new wildlife management areas in the future.

Most private wetland areas are not managed as wildlife refuges but as hunting clubs. They are, however, closely connected to the public refuges and wildlife management areas because most birds will use both areas. Additionally, the interconnected water supply channels serve both the public and private areas and act as one supply network. Because of this interconnection and the importance of the private wetlands in the Grassland watershed, the beneficial use of Preservation of Biological Habitats of Special Significance (BIOL) is proposed for all the water supply channels within the wetland areas.

Table 3: Hierarchy and Current Uses of Northern Grassland Wetland Channels

	Wetland Supply Conveyance	Wetland Diversion	Wetland Drainage Conveyance	Ag Supply Conveyance	Subsurface Ag Drainage	Starting Location	Ending Location
I. CCID Main Canal (CVP Supply)							
A. Garzas Creek	■	■	■			Enters Grassland Water District (GWD) at the intersection of Sections 22, 23, 26,27 T.8S, R.9E	Discharges to Los Banos Creek NE 1/4, NE 1/4, NE 1/4, Sec. 26, T.8S, R.9E
1. Westside Ditch	■	■	■			Diversion of Garzas Cr at the intersection of Sections 22, 23, 26, 27, T.8S, R.9E	Discharges to Los Banos Creek at the SE 1/4, NW 1/4, NW 1/4, Sec. 11, T.8S, R..9E
B. San Luis Canal	■	■	■	■	■	Starts at a diversion of the Main Canal at NE 1/4, NW 1/4, SW 1/4, Sec. 36, T.10S, R.10E	NE 1/4, NE 1/4, SW 1/4, Sec. 5, T.8S, R.10E
1. Standard Ditch	■	■	■	■		Diversion from San Luis Canal at the NE 1/4, SE 1/4, NE 1/4, Sec. 25, T.9S, R.10E	Terminates at the NE 1/4, NE 1/4, SW 1/4, Sec. 15, T.9S, R.10E
2. Fremont Ditch	■	■	■		■	Diversion from San Luis Canal at the SE 1/4, SW 1/4, SW 1/4, Sec. 35, T.8S, R.10E	Discharges to Mud Slough (north) at the NW 1/4, NW 1/4, NE 1/4, Sec. 20, T.8S, R.10
C. Los Banos Creek	■	■	■			Begins service at CCID Main Canal at the SE 1/4, SW 1/4, SW 1/4, Sec. 9, T.10S., R.10E	Discharges to Mud Slough (north) at the NE 1/4, NW 1/4, SW 1/4, Sec. 26, T.7S, R.9E
1. Gun Club Road Ditch	■	■	■			Diversion of Los Banos Cr at the intersections of Sections 13, 14, 23, 24, T.8S, R.9E	Terminates at Eagle Ditch at the SW 1/4, SE 1/4, SE 1/4, Sec. 13, T.8S, R.9E
II. Santa Fe Canal[1]	■	■	■	■	■	Extension of the Arroyo Canal at Mueller Weir at the NW 1/4, SW 1/4, SW 1/4, Sec. 21, T.10S, R.11E	Terminates at a tributary of Mud Slough (north) at the SW 1/4, SW 1/4, SE 1/4, Sec. 7, T.8S, R.10E
1. Eagle Ditch	■	■	■			Diversion of the Santa Fe Canal at the NE 1/4, SE 1/4, NE 1/4, Sec. 30, T.8S, R.10E	Discharges to Mud Slough (north) at the SW 1/4, SE 1/4, NE 1/4, Sec. 7, T.8S, R.9E
2. Kesterson Ditch	■	■				Diversion of the Santa Fe Canal at the SE 1/4, SE 1/4, SW 1/4, Sec. 32, T.8S, R.10E	Terminates at the NW 1/4, NW 1/4, SE 1/4, Sec. 34, T.8S, R.10E

[1] Begins as an extension of the Arroyo Canal. Receives only SLCC operational spill water at this point.
[2] Source is the Delta-Mendota Canal

Table 3: Hierarchy and Current Uses of Northern Grassland Wetland Channels (continued)

3. Santa Fe Canal Extension	■	■	■			Diversion of the Santa Fe Canal at the SW 1/4, Sec. 7, T.8S, R.10E	
III. San Luis Wasteway[2]							
1. Mosquito Ditch	■	■	■			Diversion from the San Luis Wasteway at the NE 1/4, NW 1/4, NW 1/4, Sec. 19, T.9S, R.10E	Discharges to Los Banos Creek at NE 1/4, NE 1/4, SE 1/4, Sec. 6, T.9S, R10E
2. San Luis Spillway Ditch	■	■	■			Diversion of the San Luis Wasteway at the intersections of Sections 17, 18, 19, 20, T.9S, R.10E	Discharges to the Santa Fe Canal at SE 1/4, SE 1/4, SW 1/4, Sec. 16, T.9S, R.10E
3. Rubino Ditch	■	■	■			Diversion of the San Luis Spillway at the SW 1/4, SE 1/4, SW 1/4, Sec. 17, T.9S, R.10E	Terminates at the NW 1/4, SW 1/4, SW 1/4, Sec. 8, T.9S, R.10E

[1] Begins as an extension of the Arroyo Canal. Receives only SLCC operational spill water at this point.
[2] Source is the Delta-Mendota Canal

Table 4: Hierarchy and Current Uses of Southern Grassland Wetland Channels

	Wetland Supply Conveyance	Wetland Diversion	Wetland Drainage Conveyance	Ag Supply Conveyance	Ag Subsurface Drainage Conveyance	Starting Location	Ending Location
I. CCID Outside Canal (CVP Supply)							
A. Charleston Drain	■	■	■		■	Freshwater diversions from the Outside Canal at the SW1/4, SW1/4, NE1/4, Sec. 32, T11S, R11E	Discharges to Upper Gadwall Ditch at the SW1/4, SW1/4, NW1/4, Sec. 6, T11S, R11E
II. CCID Main Canal (CVP Supply)							
A. Helm Canal	■	■				Takeouts from the Main Canal at NE1/4, SE1/4, NE1/4, Sec. 31, T11S, R11E	Terminates at the Helm Canal extension at the SW1/4, SW1/4, NW1/4, Sec. 26, T11S, R11E
1. 240 Ditch	■	■	■			Diversion from Helm Canal at NE1/4, NW1/4, NW1/4, Sec. 36, T11S, R11E	Terminates at Sorsky Ditch at NE1/4, NW1/4, NE1/4, Sec. 23, T11S, R11E
2. Meyers Ditch	■	■				Diversion from Helm Canal at SE1/4, SW1/4, SW1/4, Sec. 26, T11S, R11E	Terminates at the SE1/4, SW1/4, SW1/4, Sec. 23, T11S, R11E
3. Sorsky Ditch	■	■	■			Diversion of Camp 13 and continuation of Sorsky Bypass at the NE1/4, NW1/4, NW14, Sec. 27, T11S, R11E	Discharges to Camp 13 at SW1/4, SW1/4, SW1/4, Sec. 3 T11S, R11E
B. Gables Ditch	■	■				Diversion of Main Canal at the NE1/4, NW1/4, NW1/4, Sec. 31, T11S, R12E	Terminates at the SW1/4, NW1/4, SW1/4, Sec. 18, T11S, R12E
C. Agatha Canal South	■	■	■		■	Diversion from Helm or Main Canal at NW1/4, SE1/4, NE1/4, Sec. 31 T11S, R12E	Terminates at the Agatha North/Geis split at NE1/4, SE1/4, SE1/4, Sec. 12, T11S, R11E
1. Agatha Canal North	■	■	■		■	Starts at the Agatha North/Geis split at NE1/4, SE1/4, SE1/4, Sec. 12, T11S, R11E	Discharges to the Santa Fe Canal at Mueller Weir at NW1/4, SW1/4, SW1/4, Sec. 21, T10S, R11E
a. Pozo Drain	■	■	■		■	Enters the GWD at SW1/4, SW1/4, SW1/4, Sec. 8, T11S, R12E	Discharges to the Agatha Canal North at the NE1/4, SE1/4, NE1/4 Sec. 12, T11S, R12E

Table 4: Hierarchy and Current Uses of Southern Grassland Wetland Channels (continued)

2. Almaden Ditch	■	■	■			Begins at the Agatha Canal at Mallard Rd at SE1/4, NE1/4, SE1/4, Sec. 12, T11S, R11E	Terminates at Mesquite Drain siphon at the SW1/4, SW1/4, SW1/4, Sec. 11, T11E, R11E
3. Geis Ditch	■	■	■		■	Begins at the Agatha North/Geis split at the NE1/4, SE1/4, SE1/4, Sec. 12, T11S, R11E	Discharges to Camp 13 at NW1/4, NW1/4, SW1/4, Sec. 3, T11S, R11E
4. Mud Slough (south)	■	■	■	■	■	Begins at the end of Camp 13 at the SE1/4, NE1/4, NE1/4, Sec. 33, T10S, R11E	Discharges to Salt Slough at the Los Banos WA at the NW1/4, NE1/4, SW1/4, Sec. 18, T9S, R10E
D. Camp 13	■	■	■		■	Diversion of the Main Canal or Main Drain or Hamburg Drain at the SW1/4, SE1/4, SE1/4, Sec. 27, T11S, R11E,	Discharges to Mud Slough (south) at the SE1/4, NE1/4, NE1/4, Sec. 33, T10S, R11E
1. Upper Gadwall Ditch	■	■	■		■	Diversion of Camp 13 at the NW1/4, SE1/4, SE1/4, Sec. 22, T11S, R11E	Terminates at Reedly Ditch at the NE1/4, NE1/4, NE1/4, Sec. 8, T11S, R11E
2. Britto Ditch	■	■	■			Diversion from Camp 13 at the NW1/4, SE1/4, NE1/4, Sec. 22, T11S, R11E	Terminates at the SW1/4, SE1/4, NE1/4, Sec. 10, T11S, R11E
3. Sorsky Ditch	previously	described					
4. Cotton Drain	■	■	■			Enters the Grassland at the NW1/4, NE1/4, SE1/4, Sec. 32, T10S, R11E	Discharges to Mud Slough (s) at the SE1/4, SW1/4, SE1/4, Sec. 28, T10S, R11E
E. Almond Drive Ditch	■	■	■			Diversions from the Main Canal and Main Drain at the SW1/4, SW1/4, SW1/4, Sec. 6, T11S, R10E	Discharges to Reedly Ditch at SW1/4, SW1/4, SW1/4, Sec. 5, T11S, R10E
1. Flyway Ditch	■	■				Diversion from Almond Dr. Ditch at SE1/4, SW1/4, SW1/4, Sec. 5, T11S, R11E	Discharges to Cotton Drain at the NW1/4, SE1/4, NE1/4, Sec. 32, T10S, R11E
2. Lower Gadwall Canal	■	■	■		■	Continuation of the upper Gadwall, starts at the Almond Dr. intersection at the SE1/4, SE1/4, SE1/4, Sec. 5, T11S, R11E	Discharges to Mud Slough (south) at the NE1/4, NE1/4, NW1/4, Sec. 33, T10S, R11E

Table 4: Hierarchy and Current Uses of Southern Grassland Wetland Channels (continued)

3. Reedly Ditch	■	■	■		■	Continuation of Almond Dr. Drain at the SW1/4, SW1/4, SW1/4, Sec. 4, T11S, R11E	Discharges to Camp 13 at the SE1/4, SE1/4, SE1/4, Sec. 4, T11S, R11E
F. Ascot Ditch	■	■		■		Diversion from the Main Canal at the SE1/4, SW1/4, SW1/4, Sec. 7, T11S, R11E	Terminates at the SW1/4, SE1/4, SE1/4, Sec. 8, T11S, R11E
III. CCID Colony Canal							
A. Colony Branch 2	■	■	■			Enters the Southern Grassland at the SW1/4, NW1/4, SW1/4, Sec. 8, T11S, R12E	Drains into Bennett Drain at the NE1/4, SE1/4, NE1/4, Sec. 7, T11S, R12E
B. Colony Branch 3/Bennett	■	■	■			Enters the Southern Grassland at the SE1/4, SW1/4, SW1/4, Sec. 5, T11S, R12E	Terminates at the Agatha Canal North at the SW1/4, SW1/4, SW1/4, Sec. 6 T11S, R12E
C. Stillbow Ditch	■	■	■			Begins at Bennett Ditch at the SW1/4, SE1/4, SW1/4, Sec. 6, T11S, R12E	Discharges to the Agatha Canal North at the SW1/4, NW1/4, NW1/4, Sec. 36, T10S, R11E
D. Line Ditch	■	■				Enters Grassland at the SW1/4, SE1/4, NE1/4, Sec. 5, T11S, R12E	Terminates at the NE1/4, NE1/4, NE1/4, Sec. 6, T11S, R12E
IV. SLCC Arroyo Canal	■	■		■		Enters the Southern Grassland at the NE1/4, SE1/4, NE1/4, Sec. 25, T10S, R11E	Discharges to the Santa Fe Canal at Mueller Weir at the NW1/4, SW1/4, SW1/4, Sec. 21, T10S, R11E
A. San Pedro Canal	■	■		■		Diversion from the Arroyo Canal at the NW1/4, NE1/4, NW1/4, Sec. 26, T10S, R11E	Discharges to Boundary/ Devon Drain at the NE1/4, NE1/4, SE1/4, Sec. 31, T9S, R11E
B. Cocke Ditch	■	■		■		Diversion from the Arroyo Canal at the NE1/4, SW1/4, SW1/4, Sec. 21, T10S, R11E	Terminates at the NW1/4, SE1/4, SE1/4, Sec. 16, T10S, R11E

Figure 3a Grasslands Area

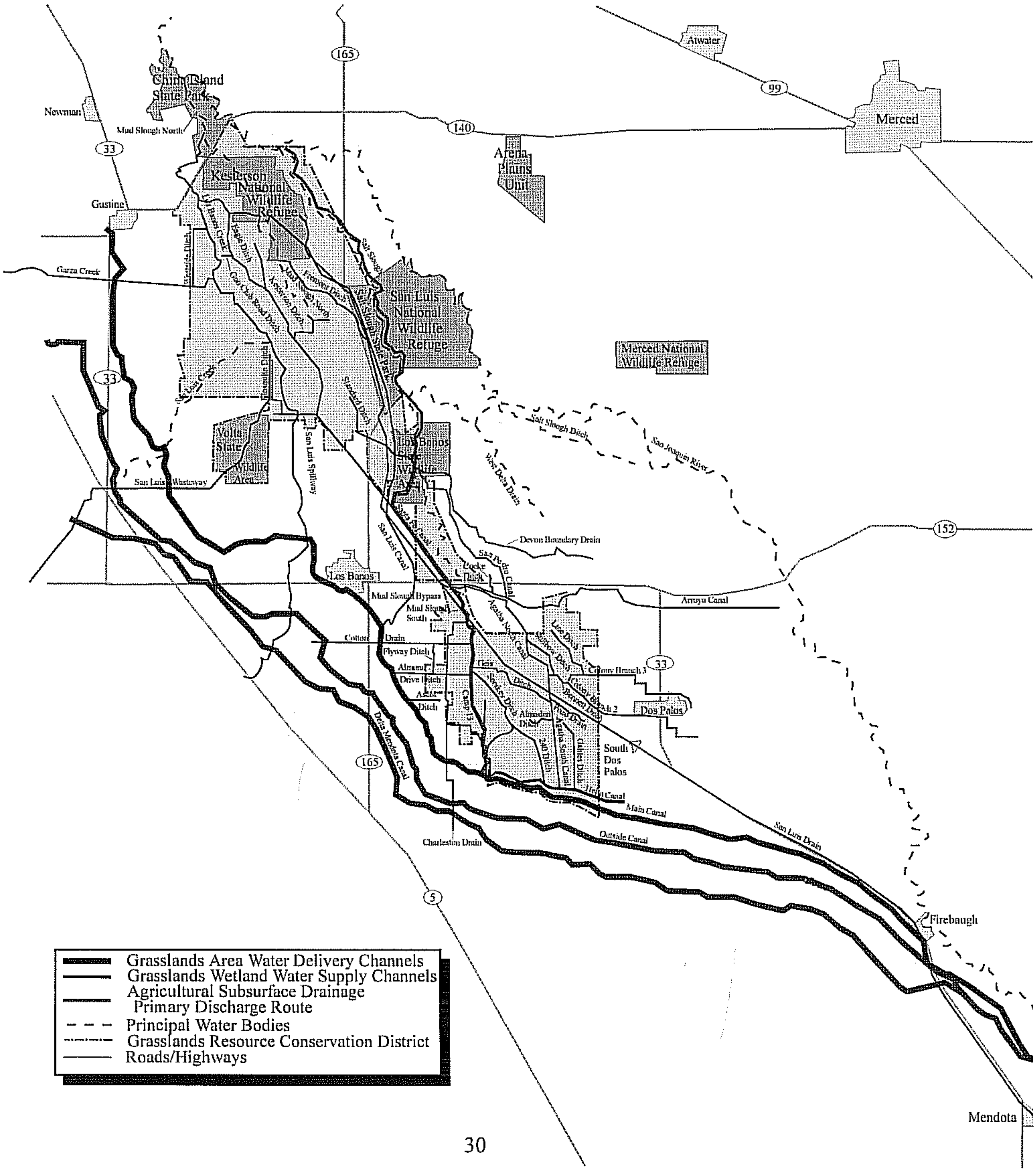
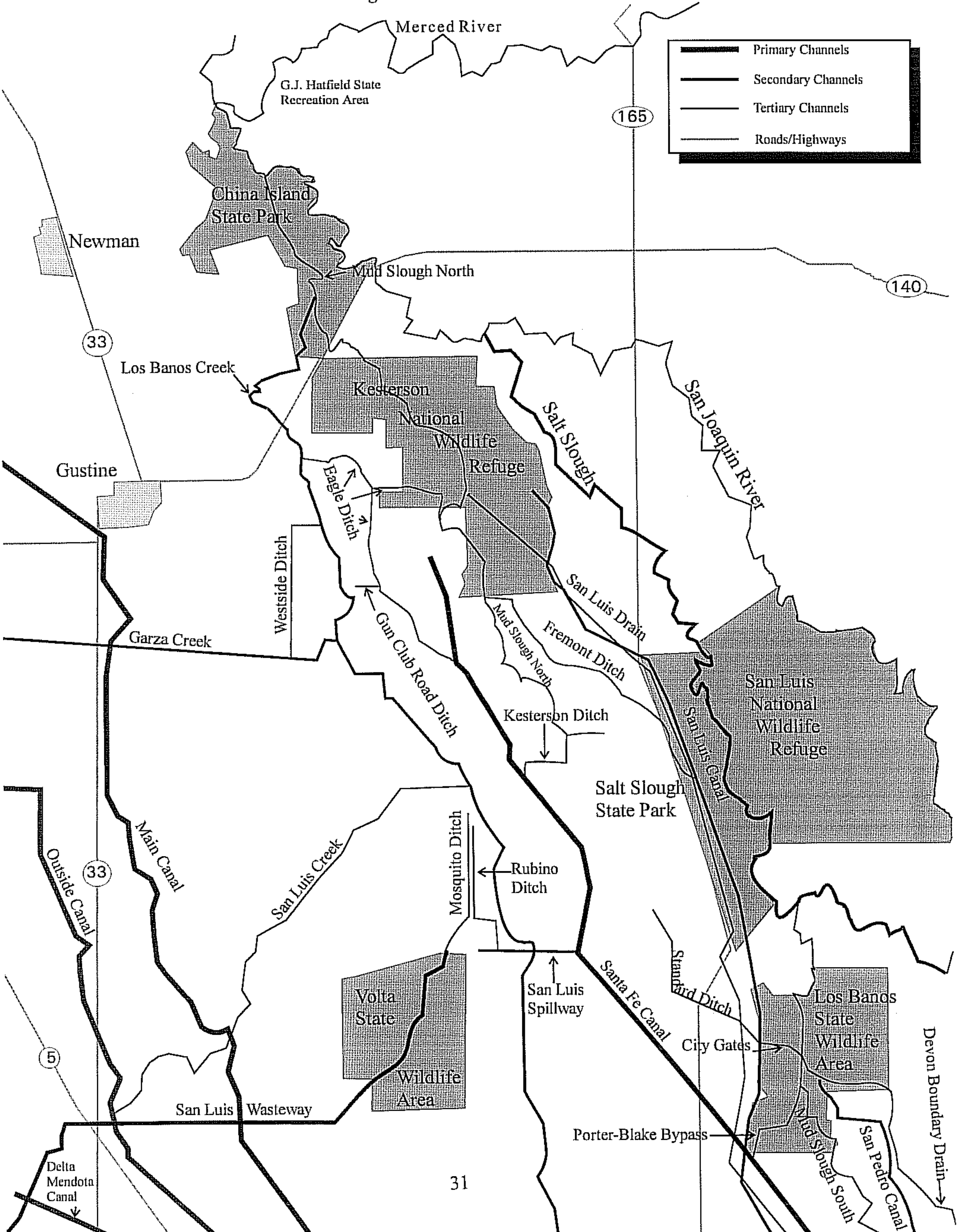


Figure 3b Northern Grasslands Area



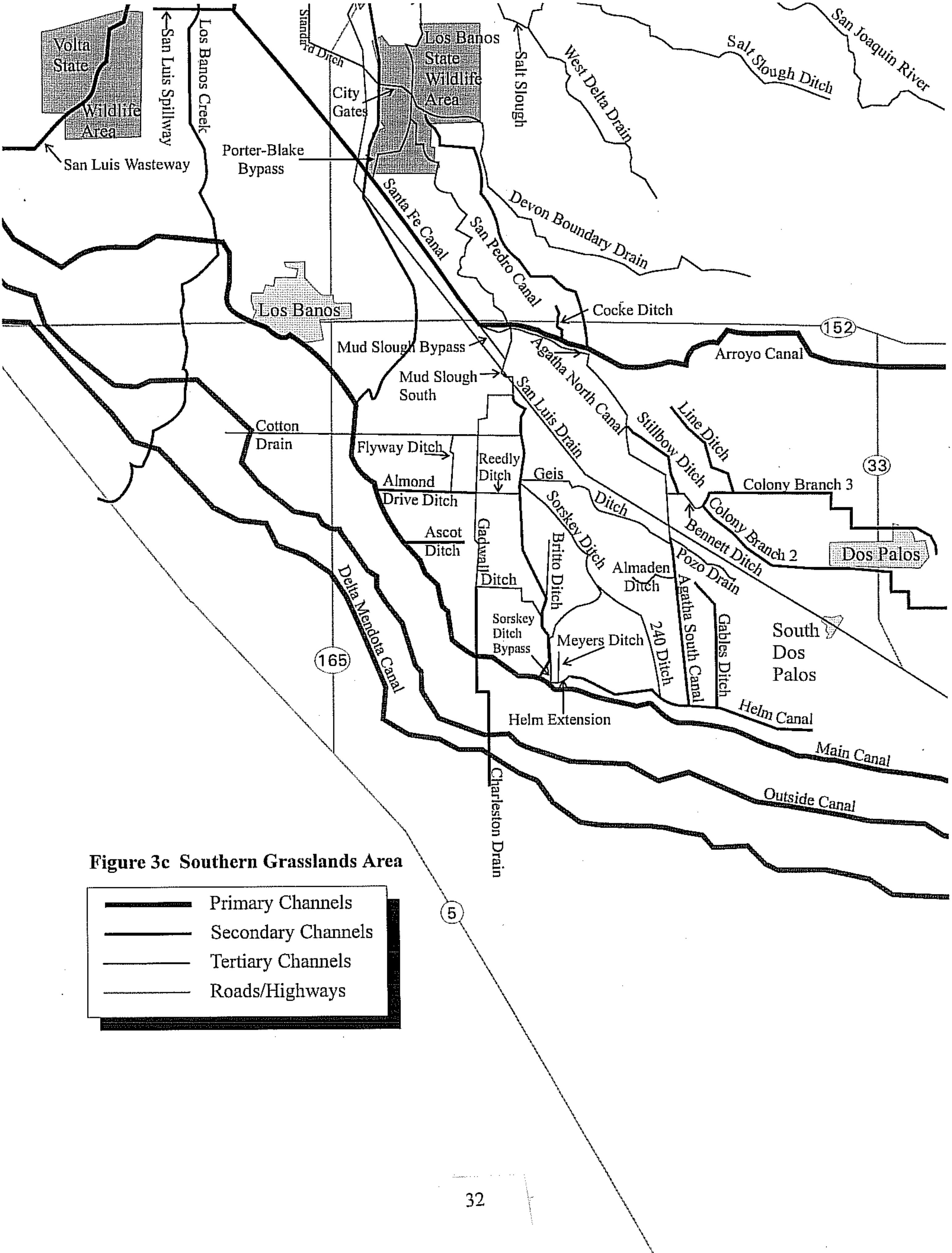


Figure 3c Southern Grasslands Area

(thick line)	Primary Channels
(medium line)	Secondary Channels
(thin line)	Tertiary Channels
(fine line)	Roads/Highways

PART III SELENIUM WATER QUALITY CRITERIA THAT ARE PROTECTIVE OF VARIOUS BENEFICIAL USES

Water quality criteria are numerical concentration limits that provide full protection of a designated beneficial use. Water quality criteria are based on the best available scientific information. National water quality criteria have been developed for several pollutants, including selenium. These national criteria are to be used as guidance by the states in developing their numerical values (water quality objective) to protect a designated beneficial use. States may also elect to develop alternative site specific criteria that are scientifically based and defensible.

Where there are multiple uses designations, 40CFR §131.11(a)(1) of the Federal Clean Water Act requires that the criteria protect the most sensitive use. For the proposed beneficial uses presented in this report, the most sensitive use with respect to selenium is likely wildlife habitat. The next most sensitive use is aquatic life. These two uses will form the basis for discussion of pertinent criteria although other uses are presented. The source of data for this discussion include U.S. EPA Ambient Water Quality Criteria for Selenium, State Water Board Technical Committee Report, University of California (UC) Committee of Consultants Report, and other scientific publications.

AQUATIC LIFE PROTECTION

U. S. EPA National Water Quality Criteria

The U.S. EPA has published an ambient water quality criteria for selenium (USEPA, 1987). The available toxicity data was presented in this document according to U.S. EPA guidelines. The criteria recommended however was driven by data from Belew Lake in North Carolina. This lake was used for cooling water for a coal burning power plant. The lake had been contaminated with selenium from the power plant. Adverse impacts were noted to aquatic species at an ambient water concentration of 10 μg/L selenium. Data from feeding studies was presented that supported selenium as the cause of the adverse effects.

At the upstream segment of the lake, however, there were no observed adverse impacts. The ambient water concentration for selenium was at or near the detection limit of 5 μg/L. This information formed the basis upon which the U.S. EPA recommended for protection of freshwater aquatic life that the 4-day average concentration of selenium be set at 5 μg/L and this concentration should not be exceeded more than once every three years on average.

A maximum concentration criterion was also derived from the toxicity data. The U.S. EPA recommended that a 20 μg/L, one-hour average value should not be exceeded more than once every three years on average to protect aquatic life.

State Water Board Technical Committee

As part of the State Water Board evaluation of selenium impacts, a State Water Board Technical Committee calculated aquatic life criteria using two methods (SWRCB, 1987). The first was based on bioaccumulation and the second based on toxicity.

The committee analyzed the literature and developed regression equations to relate water selenium concentrations with concentrations of selenium in tissue of a variety of organisms (e.g. algae, fish, etc.). Toxicology data for fish was then analyzed to determine the three lowest data points demonstrating an adverse effect. A geometric mean of these three values was then defined as the adverse effect level. The no adverse effect level was then estimated from the log mean of the background concentration and the adverse effect level. This value was calculated at 1.1 ppm selenium in fish tissue. This value was then related to a water selenium concentration using a regression equation. A criterion of 0.9 μg/L was obtained.

In there evaluation of bioaccumulation data, the technical committee identified two trends in bioaccumulation factors (BCF) in relation to ambient water selenium concentrations. One for the national data, which was developed primarily from lakes and reservoirs and the other for San Joaquin River system which appeared to be one order of magnitude lower than that observed for the national data. The committee attributed these difference to impounded waters and flowing waters. However, they rejected calculating a criterion for flowing systems because of too many uncontrolled variables (spatial and temporal variability of selenium concentrations).

The second method used to calculate a water criterion for selenium to protect aquatic life was based on the modified Ocean Plan Method. In this method a criterion is calculated that must lie between the highest no observed adverse effect level (estimated by a background concentration) and the lowest observed no adverse effect level. This procedure does not account for variables such as hardness and is focused on acute toxicity of the most sensitive species and life stages. For selenium, embryonic vertebrates and planktonic crustaceans were defined as the most sensitive.

The method involved ranking the adverse effect bioassay data of the most sensitive species; calculating the adverse effect level (AEL) as the geometric mean of the three lowest adverse effect data points; calculating the criterion as the geometric mean of the AEL and background concentration. Using a background concentration of 0.2 μg/L and AEL of 26.3 μg/L, a criterion of 2.3 μg/L was calculated.

UC Committee of Consultants

A University of California Committee of Consultants conducted a review and offered an opinion on the criteria developed by the State Water Board Technical Committee. The review was critical of separating impounded versus flowing systems. The committee felt there was a lack of scientific rationale for separating these two systems. Additionally, they cited Saiki, where his data shows there was no difference in bioaccumulation factor (BAF) for flowing and impounded systems. The data of Saiki is for flowing and impounded systems in the San Joaquin River Basin. This suggests that differences in BAF, if they exist, may be due to site specific factors rather than flowing versus impounded systems. Further evidence for a difference between data for the San Joaquin River and the remainder of the nation lies in the observation by the committee that selenium tissue concentrations did not change significantly within the range of 0.3 to 2 μg/L for the impounded water (national water data) and 1 to 4 μg/L for the flowing (San Joaquin River Basin data).

The committee while endorsing the bioaccumulation approach to developing a selenium criterion, was critical of the method. Specifically, they were critical of using regressions to select a no observed adverse effect level. The committee felt that the correlation coefficients were not adequate and that a non-linear equation may better describe the relationship.

For the toxicity derived criteria, the committee calculated a value based on new chronic toxicity data for a sensitive species (*Daphnia pulicaria*). An alternative criterion of 1.5 μg/L was calculated. An acute value of was estimated for this species based on the observed chronic to acute ratio of 10 for daphnia. The final criterion suggested was 1.0 μg/L.

Other Scientific Literature

In 1994, Maier and Knight conducted a review of available toxicological data. They summarized available water quality criteria from the scientific literature and water quality objectives and criteria from various regulatory agencies. Of the eight reports cited (three have already been presented above) , values for waterborne exposure ranged from 0.1 to 5 μg/L. The values from the scientific literature included aquatic life as well as wildlife that utilize aquatic systems.

In their review of adverse effects, Maier and Knight found adverse effects occurring at waterborne concentrations ranging from 2.7 μg/L to 10 μg/L. The adverse effect reported at 2.7 μg/L was for an evaporation pond system (Skorupa and Ohlendorf, 1991) . Adverse effects for organisms that would be observed in a stream were reported at 10 μg/L (Malchow, 1990; Hermanutz et al., 1992). Maier and Knight suggested a toxicity threshold of 2.7 μg/L.

A recent internal U.S. EPA memo from the Environmental Research Lab in Duluth (Stephan, 1994) also concludes that research performed since 1987 suggests that the selenium criterion should not be greater than 5 μg/L to protect freshwater aquatic life.

WETLANDS AND WILDLIFE PROTECTION

Adopted Water Quality Objectives

The Central Valley Regional Board and the State Water Board have determined that a 2 μg/L monthly mean selenium objective for wetland waters is necessary to protect waterfowl (State Water Board Resolution No. 89-88). The U.S. EPA approved this objective in April 1990.

Scientific Literature

Since adoption and U.S. EPA approval, reported scientific studies indicate that a 2 μg/L criteria is below the toxic threshold for waterfowl. Skorupa and Ohlendorf (1991) report that concentrations of waterborne selenium less than 0.5 μg/L are necessary to avoid accumulation in bird populations above what would be considered natural background concentrations. They also report that ambient water concentrations in excess of 2.7 μg/L may cause reduced hatchability in waterfowl eggs. DuBowy as cited in Maier and Knight (1994), report water concentrations of less than 2.8 μg/L are needed to protect waterfowl from reproductive toxicity. Peterson and Nebeker as cited in Maier and Knight (1994), suggest a waterborne selenium criterion ranging from 0.7 to 2.1 μg/L for protection of wildlife utilizing aquatic ecosystems.

AGRICULTURE USE PROTECTION

The State Water Resources Control Board Technical Committee Report suggested a selenium criterion of 20 μg/L for agricultural water supply. No change is proposed in this criterion.

MUNICIPAL AND DOMESTIC SUPPLY PROTECTION

The current state of California MCL for human consumption of water containing selenium is 50 μg/L. No change is proposed in this criterion.

INDUSTRIAL USE PROTECTION

There are no known criterion for waterborne selenium concentrations for industrial use. No criterion for this beneficial use is proposed.

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